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Consumption, leisure and earnings-related liquidity constraints

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Publication date:
1987

[Link to publication in Tilburg University Research Portal](#)

Citation for published version (APA):

Alessie, R. J. M., Melenberg, B., & Weber, G. (1987). *Consumption, leisure and earnings-related liquidity constraints: A note*. (Research memorandum / Tilburg University, Department of Economics; Vol. FEW 295). Unknown Publisher.

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DEPARTMENT OF ECONOMICS
RESEARCH MEMORANDUM



**CONSUMPTION, LEISURE AND EARNINGS-
RELATED LIQUIDITY CONSTRAINTS: A NOTE**

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FEW 295

330.115

Consumption, Leisure and Earnings-Related Liquidity Constraints:
A Note.

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November 1987

The results in this note were independently derived by G. Weber and by R. Alessie and B. Melenberg. R. Alessie and B. Melenberg wish to thank A. Kapteyn and Th. Nijman for valuable comments and R. Alessie gratefully acknowledges the Netherlands Organization for the Advancement of Pure Research and the NMB Bank in the Netherlands for financial support. G. Weber is grateful for helpful discussions with M. Browning and F. Schiantarelli.

Abstract

The life-cycle model with liquidity constraints produces an Euler equation with unobservable Kuhn-Tucker multipliers. If borrowing restrictions depend on earnings, preferences are non-separable between goods and leisure, and individuals are employed, we derive an Euler equation involving only observable variables.

1. Introduction

Recent studies of intertemporal behaviour in a risky environment have adopted the Euler equation approach introduced by Hall (1978). Assuming perfect capital markets, strongly separable preferences between goods and leisure and rational expectations, Hall showed that the marginal utility of consumption is a random walk.

However, several empirical papers have rejected the restrictions implied by Hall's version of the Life-cycle Model (Flavin, 1981, Hall and Mischkin, 1982, Hayashi, 1985 and Weber, 1987). Liquidity constraints and preference interactions between goods and leisure have alternatively been put forward as likely explanations of this failure.

As Muellbauer (1983), Zeldes (1985) and others point out, the Euler equation for consumption with borrowing restrictions contains an additional (unobservable) explanatory variable, the Kuhn-Tucker multiplier associated with the net wealth condition. In this note, we argue that a simple analytical framework for incorporating both earnings-dependent liquidity constraints and non-separable preferences is readily available, and we show that under weak conditions it produces an Euler equation involving only observable variables.

This note is organized as follows: in section 2 we establish our notation, and derive the standard Euler equation. Section 3 presents our proposed extension, and discusses its empirical implications. Section 4 draws some conclusions.

2. The Life-cycle model with Liquidity Constraints

We assume that goods and leisure are choice variables, and that capital markets are imperfect. Consequently, consumers solve the following optimization problem:

$$\max E_t \sum_{\tau=t}^L (1+\rho)^{t-\tau} u_{\tau}(c_{\tau}, l_{\tau}) \quad (1)$$

$$\text{s.t.} \quad A_{\tau} = (1+r_{\tau-1})A_{\tau-1} + m_{\tau} + w_{\tau}(T-l_{\tau}) - p_{\tau}c_{\tau} \quad \tau = t, \dots, L \quad (2)$$

$$A_{\tau} \geq M_{\tau} \quad \tau = t, \dots, L \quad (3)$$

$$l_{\tau} \leq T \quad \tau = t, \dots, L \quad (4)$$

$$A_{t-1} \text{ given, } A_L = 0,$$

where

$u_{\tau}(\dots) :=$ Intratemporal utility function¹⁾,

$\rho, r_{\tau-1} :=$ Time preference and interest rates, respectively,

$c_{\tau}, l_{\tau} :=$ Goods and leisure in period τ , respectively,

$A_{\tau} :=$ Non human wealth at the end of period τ ,

$m_{\tau} :=$ Non labour income in period τ ,

$p_{\tau}, w_{\tau} :=$ Goods price and wage rate in period τ ,

$L, T :=$ Length of life and time endowment.

The first order conditions for period t are:

$$\frac{\partial u_t(c_t, l_t)}{\partial c_t} = \lambda_t p_t \quad (5)$$

$$\frac{\partial u_t(c_t, l_t)}{\partial l_t} = \lambda_t w_t + \nu_t \quad (6)$$

$$\lambda_t - \mu_t = E_t(1+r_t)/(1+\rho)\lambda_{t+1} \quad (7)$$

$$\mu_t(A_t - M_t) = 0; \nu_t(T - l_t) = 0 \quad (8)$$

$$\mu_t \geq 0; \nu_t \geq 0 \quad (9)$$

The variables λ_t , λ_{t+1} denote the Lagrange multipliers associated to (2), whereas μ_t and ν_t are the Kuhn-Tucker multipliers corresponding to the borrowing and the time constraints, (3) and (4), respectively.

By using (5) we can rewrite the Euler equation (7) as

$$\frac{(1+r_t)}{(1+\rho)} \cdot \frac{1}{p_{t+1}} \cdot \frac{\partial u_{t+1}(c_{t+1}, l_{t+1})}{\partial c_{t+1}} = \frac{1}{p_t} \frac{\partial u_t(c_t, l_t)}{\partial c_t} - \mu_t + \epsilon_{t+1} \quad (10)$$

where the error has zero conditional mean.

For estimation purposes, equation (10) is unsatisfactory in that it contains the unobservable, endogenous variable μ_t . Only in special cases a closed form solution can be found; moreover, in general, no information can be gleaned from equation (10) as to whether liquidity constraints are operating, i.e. whether μ_t is positive or zero.

The only case where equation (10) can be used to assess the importance of liquidity constraints is where prior information is available: if we know that for some observations μ_t is zero, then we can estimate (10) on this subsample and thus compute predicted μ_t for the remaining observations. We can then check whether μ_t has a positive mean for the liquidity constrained as the model predicts (Zeldes, 1985). The trouble with the method is its absolute reliance on usually unavailable sample separation information.

3. An alternative approach: earnings-related liquidity constraints

Let us now assume an earnings-related liquidity constraint (as in Muellbauer, 1983):

$$A_{\tau} \geq \Psi_0 + \Psi_1 w_{\tau} (T - l_{\tau}), \quad \tau = 1, \dots, L \quad (3')$$

where Ψ_0 and Ψ_1 are parameters. We expect the borrowing limit to be inversely related to current earnings, i.e. $\Psi_1 < 0$.

In this setting the first order condition (6) becomes

$$\frac{\partial u_t(c_t, l_t)}{\partial l_t} = \lambda_t w_t - \Psi_1 \mu_t w_t + \nu_t, \quad (6')$$

and we can use (5) and (6') to obtain an expression for μ_t :

$$\mu_t = \frac{1}{\Psi_1} \left[\frac{1}{p_t} \frac{\partial u_t(c_t, l_t)}{\partial c_t} - \frac{1}{w_t} \frac{\partial u_t(c_t, l_t)}{\partial l_t} + \frac{1}{w_t} \nu_t \right]. \quad (11)$$

Finally, we substitute equation (11) into (10) and get: we get

$$\begin{aligned} \frac{(1+r_t)}{(1+\rho)} \cdot \frac{1}{p_{t+1}} \cdot \frac{\partial u_{t+1}(c_{t+1}, l_{t+1})}{\partial c_{t+1}} &= \left[1 - \frac{1}{\Psi_1} \right] \frac{1}{p_t} \frac{\partial u_t(c_t, l_t)}{\partial c_t} + \\ &+ \frac{1}{\Psi_1} \frac{1}{w_t} \left[\frac{\partial u_t(c_t, l_t)}{\partial l_t} - \nu_t \right] + \epsilon_{t+1}, \text{ with } E_t \epsilon_{t+1} = 0. \end{aligned} \quad (12)$$

We have thus obtained an Euler equation where μ_t does not appear. In its place, we now have the Kuhn-Tucker multiplier on leisure, ν_t , which is going to be positive when a corner solution obtains in the labour market. Once again, a closed form solution for this endogenous variable is unlikely to exist; however, contrary to the case of capital markets, in the case of the labour market sample separation information is readily available.

If panel data on individual households are available, we can estimate the parameters of equation (12) by the Generalized Method of Moments (Hansen and Singleton, 1982) by restricting the sample to the employed in

period t : no selection bias will arise, because the error term is orthogonal to the selection rule (as ν_t belongs to the relevant information set). We can then formally test for the absence of liquidity constraints (i.e. by setting $1/\Psi_1=0$ in equation (12)) by standard statistical methods.

Some further remarks on equation (12) are in order:

- 1) equation (12) holds whether a consumer is liquidity constrained or not and whether he is rationed in his labour supply choice in period $t+1$ or not;
- 2) equation (12) can only be derived if Ψ_1 differs from zero. The limit case where Ψ_1 equals zero is discussed in section 2: in this case standard rules for within period allocation of full expenditure into goods and leisure are unaffected by the presence of a binding constraint in the capital market (Blundell and Walker, 1986);
- 3) consistent estimates of the parameters in equation (12) can be obtained by truncating the sample to include only the workers. Such estimates can then be used to compute ν_t for non workers, which should be positive (this prediction provides a simple specification check);
- 4) we can use equations (10) or (11) and the parameter estimates from (12) to compute μ_t for each individual household.

The relationship between the formal test for $(1/\Psi_1)=0$ and the informal computation of μ_t is worth exploring. Inspection of equation (12) and consideration of the underlying model suggest that rejection of the null in the formal test does not imply that the estimated μ 's should be zero: it is in fact possible for consumers not to be bound by the liquidity constraint in period t even though the earnings-related constraint exists in a non trivial form (i.e. $\Psi_1 > -\infty$).

4. Conclusions

In this paper we started from the well known result that the life-cycle model with liquidity constraints produces an Euler equation with unobservable Kuhn-Tucker multipliers. We then showed that if borrowing restrictions depend on earnings and leisure is a choice variable, the

Euler equation involves only observable variables as long as we only select those consumers who are employed in period t .

Notes

1) We assume c_t and l_t to be strictly positive, for example, by imposing enough regularity conditions on $u_\tau(\dots)$.

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